I – Problem Statement Title (04-EQ091)

Detailing Requirements to Ensure Adequate Plastic Hinge Ductility of Columns Subject to Torsional Seismic Loading

II – Research Problem Statement

Question: Is conventional detailing of bridge columns an adequate practice for ensuring the safety of single column connector structures and other bridges subject to torsional seismic loading?

III – Objective

Experimentally, the research is to test prototype reinforced concrete bridge columns subjected to torsional loading. The results are needed to confirm ductility capacity of single columns supporting connectors aligned on curves with small radius or columns offset from the center of the superstructure mass such as C-Bents. The geometry of these connectors subjects them to high torsional earthquake loading, especially where abutments are not designed to resist considerable lateral forces.

Analytically, the research objective is to develop an understanding of the fundamental properties of the ductility capacity of plastic hinges subject to high levels of seismically induced torsion. These properties include ultimate curvature and displacement capacities currently needed in the design of bridge columns subjected to torsion. Optimization of detailing and the amount of reinforcement required are to be investigated.

IV – Background

Current codes and specifications covering the design of columns lack data on the effect of torsional loading. Previous tests conducted on columns include variation in the biaxial loading, the level of axial force and the level of shear stress. All of these tests have helped Department engineers to create specific guidelines on these effects. Torsional loading has been not been considered in previous tests and must now be investigated as it can induce severe damage on a specific class of California bridges. Available resources for the design against torsional loading indicate the need for a double layer of reinforcement not commonly provided in bridge column construction. The need to investigate the adequacy of conventional detailing is paramount for ensuring the safety of bridge connectors.

V – Statement of Urgency and Benefits

A. Support of the Departments Mission/Goals:
(Improving Mobility: Safety, and Reliability) The resolution of this issue will ensure the safety of bridges (single column connectors) subjected to earthquake loading by improving column reinforcement details and reducing the potential for bridge closure

following a large seismic event. This type of bridge is typically located in high traffic urban areas of the state, and is of a critical nature for connecting major routes.

B. Return on Investment:

The state of design practice for bridges in California is contingent on the ductility of the column hinging mechanism. The proposed research would confirm this approach for bridges prone to torsional loading. The objective of this proposal is to reduce economic impacts associated with bridge closures, challenges and accompanying costs of repairs of busy connectors in urban areas.

VI – Related Research

Numerous tests were conducted to investigate column hinging mechanisms subjected to biaxial lateral loading, different levels of axial force and shear stress, but not torsional loading.

VII – Deployment Potential

The results will be used to update Seismic Design guidelines where appropriate.